

Astronomy Education for the 21st century: Preserving Progress and a Phenomenal Future

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Summary: This rather brief white paper is written from one person's perspective. At this point in time, many efforts in astronomy education have become institutionalized, in that the major players have begun supporting grants programs, regular sessions at meetings, and even journals. In some previous decade reviews, the role of the Decadal Survey Committee has been limited to an endorsement of astronomy education as an appropriate activity for professional astronomers and an encouragement of individuals to do more. At this time, the Survey needs also to encourage the efforts of major national organizations as well. Furthermore, astronomers need to participate in these major efforts.

THE PAST TEN YEARS

This white paper, which represents one person's view of the current astronomy education setting, is written by someone who has a rather long time perspective on astronomy education. I was the first education officer of the American Astronomical Society (AAS) from 1979-1985. In that era, and for much of my career, astronomy education research and practice was generally carried out by energetic individuals. The scope of individual projects was generally limited. There was even a time in the early 1980s when the National Science Foundation (NSF) scarcely funded any science education efforts at all.

In the past ten years, the national interest in education, in particular science education, has been quite intense. The major funding agencies (which for astronomy means the NSF and the National Aeronautics and Space Administration, NASA) have been spending significant resources on education. In the case of the NSF, there are no programs specifically aimed at astronomy education, and astronomers who seek to take advantage of NSF resources can and do compete for funding from programs that are aimed at science education more broadly. NASA funds astronomy education as part of its efforts to increase literacy in all areas of science which are of interest to NASA. While astronomy is a major part of the sciences that interest NASA, there are other areas of science and engineering such as rocket science, space flight, human biology, earth sciences, and more.

What this has meant for the astronomy community is that there are now a substantial number of efforts in astronomy education which have become established and whose continuance is important. In my view, the foremost of these efforts is the establishment of an on-line astronomy education research journal (the Astronomy Education Review), which under the outstanding editorship of Sidney Wolff and Andy Fraknoi has grown to the point where the AAS has adopted it as one of its regular journals along with journals like Astrophysical Journal and Astronomical Journal, both of which are a century old. The AAS has now made education sessions a regular part of its national meetings.

The education efforts at NASA are a bit more fragmented. An effort to list them, which I am making here, runs the danger of leaving something important out. All NASA missions now include some kind of organized E/PO program, which includes public outreach as well as formal education. For a while, the NASA astrophysics division paid for a significant independent education program that

supported a variety of activities connected with different centers. There is a network of broker/facilitators at NASA which coordinates national efforts. NASA's Space Grant program also supports a variety of other educational activities.

The NSF supports a variety of education programs in STEM (science, technology, engineering, and mathematics). Recently, there has been an emphasis on partnerships which include people at different disciplines and in different educational levels. While astronomers have occasionally been in a position to be part of these partnerships, occasionally the relative isolation of people in some astronomy departments has been more of a barrier than it should have been.

While I'm not making any claims that this white paper covers all of the issues, it would be woefully incomplete if it did not mention the pioneering work which has been done over the years by the Astronomical Society of the Pacific. The ASP, by taking advantage of its capability to call on the community of amateur astronomers as well as professionals, has pioneered in several efforts in astronomy education that have had a great impact. They have a presence in informal education that no other science organization has. Their development of a newsletter for K-12 teachers was an important predecessor to the development of the Astronomy Education Review (the same individual, Andy Fraknoi, played a leading role in both efforts).

THE NEXT TEN YEARS

The culmination of many years of research in science education has led us to a point where we really know how to teach science, and astronomy in particular, so that students will learn with understanding. Carl Wieman's talk to the AAS a few years ago, which was published in *Physics Today* in November 2005, summarizes some of the data, including a massive study by Richard Hake that shows the benefits of interactive engagement in teaching. At the system level, states like Delaware and Washington have shown significant improvement in test scores with the introduction of new pedagogies. We don't know everything about how students learn, by any means. But we are ready to introduce some proven pedagogies on as wide a scale as possible. Astronomy needs to participate.

It seems likely that public support for education will continue for the next ten years, though we should take nothing for granted. The only possible danger for the kind of education that we astronomers are interested in is that at the K-12 level, reading and math sometimes not only take up the central part of the public stage, but crowd science education out.

I foresee a growing range of opportunities for involvement of astronomers in K-12 education, where there is considerable public pressure for improvement. The structure of astronomy, with many astronomers working in independent research centers and others working in astronomy departments at universities, does not lend itself to the natural creation of partnerships between astronomers and K-12 teachers or curriculum developers. However, experience has been that when astronomers do make contact with this community and make it clear that they are willing to be team players, that we can fully participate in efforts which are often broader in scope than just astronomy.

The details of where opportunities are going to be created will depend on the political future and on things that are certainly beyond the control of the astronomy community. We will have the

greatest and broadest impact by being aware of these opportunities and trying to be in a position to capitalize on them.

PUBLIC OUTREACH

Public outreach is closely related to education, and in some cases the two are actually coupled in an acronym: E/PO. However, they are somewhat different. Education generally takes place within a whole variety of organizations: colleges, universities, high schools, school districts, state departments of education are some of the major ones. Public outreach takes place in individual museums, TV stations and networks, websites, newsrooms, sidewalks, national parks. The ability of sustained national initiatives to make a big impact is often limited; the NSF's informal science education program generally supports individual initiatives (though with the expense of producing a major television program or series, some NASA informal science education grants are quite large). Much of public outreach in astronomy is the results of individual initiatives; it will be interesting to see whether the result of the 2009 International Year of Astronomy is more than must the sum of its parts.

WHAT THE DECADAL SURVEY CAN DO

The decadal survey process as it has evolved over the past four surveys, starting in 1960, is optimized for identifying scientific opportunities and making recommendations for infrastructure investments (such as telescopes and spacecraft) which are needed in order to take advantage of those opportunities. Science education is somewhat different from astronomy research in ways that it is not always obvious what a Decadal Survey Committee can do. I do have the advantage of having been involved in astronomy education for a number of years. I do recommend that whatever the Decadal Survey does with astronomy education should be done in close consultation with the Education Advisory Board of the AAS and with the AAS's education officer. However, this brief white paper does represent one person's viewpoint, and since I stepped down as AAS Education officer over twenty years ago, I have had little direct involvement in the administration of the AAS's education programs.

I think it would be useful for the Decadal Survey to endorse in general terms the kinds of programs that the AAS is running now. I believe that having the AAS take on the Astronomy Education Review is a particularly important step, and is one which must be continued. The number of education sessions at AAS meetings could wax and wane, the number of individuals developing astronomy simulations on the web could grow and shrink, and the number of pre-conference sessions could expand or be reduced, all in response to the level of interest. But if any of these efforts, particularly the journal, were to discontinue, a great deal of the momentum which has been built up over the past several decades would be lost.

I do not believe that the decadal survey process is in a position to make any kind of overall evaluation of such things as individual items in the AAS' suite of education programs, the E/PO programs that are associated with various missions and, in some cases, with ground-based telescopes. To a great extent, the presence or absence of these programs will result from public interest that comes from outside astronomy. NASA and the NSF have their own internal review processes which will ensure that taxpayer dollars are being spent responsibly, and there is no reason for the decadal survey process to

pre-empt those review processes. But again, a general endorsement of these efforts might make a difference in the event that some time in the next ten years, someone will ask "why is it that NASA, or the NSF, or the AAS, or some specific observatory, is in the business of education and public outreach?" There may come a time in the next ten years when the answer to this question is not the obvious one that it is now.